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Mark Scheme (Results)

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Pearson Edexcel GCE
in Physics (6PH02)
Paper 01 Physics at Work

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

Mark Scheme Notes

Underlying principle

The mark scheme will clearly indicate the concept that is being rewarded, backed up by examples. It is not a set of model answers.

For example:

(iii)	Horizontal force of hinge on table top 66.3 (N) or 66 (N) **and** correct indication of direction [no ue] [Some examples of direction: acting from right (to left) / to the left / West / opposite direction to horizontal. May show direction by arrow. Do not accept a minus sign in front of number as direction.]	✓	**1**

This has a clear statement of the principle for awarding the mark, supported by some examples illustrating acceptable boundaries.

1. Mark scheme format

1.1 You will not see 'wtte' (words to that effect). Alternative correct wording should be credited in every answer unless the ms has specified specific words that must be present. Such words will be indicated by underlining e.g. 'resonance'

1.2 Bold lower case will be used for emphasis.

1.3 Round brackets ( ) indicate words that are not essential e.g. "(hence) distance is increased".

1.4 Square brackets [ ] indicate advice to examiners or examples e.g. [Do not accept gravity] [ecf].

2. Unit error penalties

2.1 A separate mark is not usually given for a unit but a missing or incorrect unit will normally mean that the final calculation mark will not be awarded.

2.2 Incorrect use of case e.g. 'Watt' or 'w' will **not** be penalised.

2.3 There will be no unit penalty applied in 'show that' questions or in any other question where the units to be used have been given, for example in a spreadsheet.

2.4 The same missing or incorrect unit will not be penalised more than once within one question (one clip in epen).

2.5 Occasionally, it may be decided not to penalise a missing or incorrect unit e.g. the candidate may be calculating the gradient of a graph, resulting in a unit that is not one that should be known and is complex.

2.6 The mark scheme will indicate if no unit error penalty is to be applied by means of [no ue].

3. Significant figures

3.1 Use of an inappropriate number of significant figures in the theory papers will normally only be penalised in 'show that' questions where use of too few significant figures has resulted in the candidate not demonstrating the validity of the given answer.

3.2 The use of g = 10 m s^{-2} or 10 N kg^{-1} instead of 9.81 m s^{-2} or 9.81 N kg^{-1} will be penalised by one mark (but not more than once per clip). Accept 9.8 m s^{-2} or 9.8 N kg^{-1}

4. Calculations

4.1 Bald (i.e. no working shown) correct answers score full marks unless in a 'show that' question.

4.2 If a 'show that' question is worth 2 marks then both marks will be available for a reverse working; if it is worth 3 marks then only 2 will be available.

4.3 **use** of the formula means that the candidate demonstrates substitution of physically correct values, although there may be conversion errors e.g. power of 10 error.

4.4 **recall** of the correct formula will be awarded when the formula is seen or implied by substitution.

4.5 The mark scheme will show a correctly worked answer for illustration only.

4.6 Example of mark scheme for a calculation:

<u>'Show that' calculation of weight</u> Use of L × W × H Substitution into density equation with a volume and density Correct answer [49.4 (N)] to at least 3 sig fig. [No ue] [If 5040 g rounded to 5000 g or 5 kg, do not give 3rd mark; if conversion to kg is omitted and then answer fudged, do not give 3rd mark] [Bald answer scores 0, reverse calculation 2/3] Example of answer: 80 cm × 50 cm × 1.8 cm = 7200 cm^3 7200 cm^3 × 0.70 g cm^{-3} = 5040 g 5040 × 10^{-3} kg × 9.81 N/kg = 49.4 N	✓ ✓ ✓	**3**

5. Quality of Written Communication

5.1 Indicated by QoWC in mark scheme. QWC – Work must be clear and organised in a logical manner using technical wording where appropriate.

5.2 Usually it is part of a max mark, the final mark not being awarded unless the QoWC condition has been satisfied.

6. Graphs

6.1 A mark given for axes requires both axes to be labelled with quantities and units, and drawn the correct way round.

6.2 Sometimes a separate mark will be given for units or for each axis if the units are complex. This will be indicated on the mark scheme.

6.3 A mark given for choosing a scale requires that the chosen scale allows all points to be plotted, spreads plotted points over more than half of each axis and is not an awkward scale e.g. multiples of 3, 7 etc.

6.4 Points should be plotted to within 1 mm.

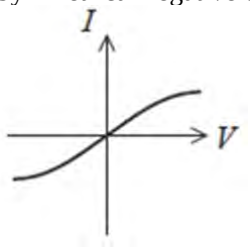
- Check the two points furthest from the best line. If both OK award mark.
- If either is 2 mm out do not award mark.
- If both are 1 mm out do not award mark.
- If either is 1 mm out then check another two and award mark if both of these OK, otherwise no mark.

For a line mark there must be a thin continuous line which is the best-fit line for the candidate's results.

Question Number	Answer	Mark
1	C	**1**
2	C	**1**
3	C	**1**
4	C	**1**
5	B	**1**
6	D	**1**
7	A	**1**
8	B	**1**
9	B	**1**
10	B	**1**

Question Number	Answer	Mark
11	Oscillations/vibrations of (air) particles/molecules/atoms **(1)** Oscillations/vibrations/displacement parallel to direction of propagation **Or** Oscillations/vibrations/displacement parallel to direction of energy transfer **(1)** (Producing) compressions and rarefactions **Or** regions of high and low pressure **Or** it is a longitudinal wave **(1)**	**3**
	Total for question 11	**3**

Question Number	Answer	Mark
12	(high resistance) so very little /negligible/zero current in the voltmeter **Or** because otherwise a current would pass through the voltmeter **Or** so the total resistance of the parallel combination isn't changed **Or** because otherwise total resistance of parallel combination would be reduced **(1)** because that would change /increase the current in the ammeter **Or** because that would mean the current through the ammeter was different to (larger than) the current through the component **(1)** .	**2**
	Total for question 12	**2**

Question Number	Answer	Mark
13(a)	Correct curve in + + section (accept $V - I$ or $I - V$ graph but axes must be labelled) **(1)** Symmetrical negative curve (accept if ++ curve incorrect) **(1)**  	**2**
13(b)	Drift velocity (of electrons) increases (as current increases) **Or** electrons gain (kinetic) energy (as current increases) **Or** rate of flow of electrons/charge increases (as current increases) **(1)** More (frequent) collisions of electrons with lattice ions **(1)** lattice ion vibrations increased **Or** (More) energy dissipated as heat in lattice **Or (**More) energy transferred when electrons collide with lattice ions **(1)** (accept charge carriers for electrons and atoms/ions/particles for lattice ions.)	**3**
	Total for question 13	**5**

Question Number	Answer		Mark
14(a)	Unpolarised – oscillations/vibrations in many directions	**(1)**	
	Polarised – oscillations/vibrations in single direction	**(1)**	
	oscillations/vibrations are perpendicular to direction of propagation	**(1)**	
	Or		
	Unpolarised – oscillations/vibrations in many planes	**(1)**	
	Polarised – oscillations/vibrations in single plane	**(1)**	
	Plane includes direction of propagation	**(1)**	**3**
14(b)	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.)		
	The idea that light transmitted only when in same plane/direction as plane/direction of polarisation of filter **Or** The idea that light not transmitted when plane/direction at 90° to plane/direction of polarisation of filter	**(1)**	
	Rays for each image are (polarised) in different planes/directions, (so only one image is seen)	**(1)**	
	When the (polarising) filter is rotated the image becomes fainter **Or** When the (polarising) filter is rotated the other image becomes visible	**(1)**	
	A statement correctly linking image(s) seen with angle. • at 90° only the other image is seen • at 180° only the 1st image is seen • at 270° only the other image is seen • at in between angles both images will be seen, (but neither at full intensity)	**(1)**	**4**
	Total for question 14		**7**

Question Number	Answer		Mark
15(a)	max kinetic energy **Or** ke_{max}	**(1)**	
	joule/J **Or** electronvolt/eV	**(1)**	
	Or	**(1)**	
	stopping potential **Or** V_s volt/V	**(1)**	**2**
	(Unit mark can be scored if no quantity given. If incorrect quantity given no marks awarded but KE/energy in joules/eV scores MP2)		
15(b)	Idea that one photon is absorbed by one electron	**(1)**	
	Photon energy given by $E = hf$ **Or** photon energy increases with frequency	**(1)**	
	The idea that there is a minimum energy needed for emission of a (photo)electron	**(1)**	
	(So) emission of electrons only occurs if frequency of light greater than the threshold frequency **Or** threshold frequency is the minimum frequency for the emission of (photo)electrons	**(1)**	**4**
	Total for question 15		**6**

Question Number	Answer	Mark
16(a)(i)	Use of $P = IV$ **(1)** Power = 2900 W **(1)** <u>Example of calculation</u> Power = 12.5 A × 230 V = 2875 W	**2**
16(a)(ii)	$P = E/t$ **(1)** Energy = 400 000 J (ecf from (i)) **(1)** <u>Example of calculation</u> Energy = 2875 W × 140 s = 402 500 J	**2**
16(a)(iii)	Use of efficiency = useful energy output / total energy input **(1)** = 0.87 or 87% (ecf from (ii)) (do not award if > 100%) **(1)** <u>Example of calculation</u> Efficiency = 351 000 J / 402 500 J = 0.87 or 87%	**2**
16(b)	Some energy transferred by heating the kettle / element / wires / surroundings **Or** Some energy transferred as sound **(1)** So not all of the (input) energy is transferred to (heating) the water **Or** so useful energy output is less than energy input **Or** only the energy heating the water is useful **(1)**	**2**
	Total for question 16	**8**

Question Number	Answer		Mark
17(a)	Photon – quantum/packet of something relevant e.g. light, radiation, any other named e-m radiation, energy (quantum/packet) of <u>electromagnetic</u> energy/radiation/waves (dependent mark)	**(1)** **(1)**	**2**
17(b)	Use of $(20.66 – 18.70) \times 1.6 \times 10^{-19}$ Use of $E = hf$ (with energy in eV or J) $f = 4.7 \times 10^{14}$ Hz <u>Example of calculation</u> $f = (20.66 – 18.70) \times 1.6 \times 10^{-19} / 6.63 \times 10^{-34}$ $f = 4.73 \times 10^{14}$ Hz	**(1)** **(1)** **(1)**	**3**
17(c)	From kinetic energy of atoms	**(1)**	**1**
17(d)	Diffraction Light spreads (sideways) as it passes through the slit Narrower slit causes more diffraction/spreading **Or** diffraction increasing as gap width gets closer to wavelength	**(1)** **(1)** **(1)**	**3**
	Total for question 17		**9**

Question Number	Answer		Mark
18(a)(i)	Determines width of at least 9 coils Use of half of their diameter in πr^2 Area = (1.96 to 2.42) × 10^{-7} (m^2) Example of calculation 18 coils = 1.00 cm Diameter = 0.0100 m ÷ 18 = 5.56 × 10^{-4} m Area = $\pi \times (5.56 \times 10^{-4} \div 2)^2$ Area = 2.42 × 10^{-7} m^2	**(1)** **(1)** **(1)**	**3**
18(a)(ii)	Use of $R=\rho l/A$ Resistivity magnitude = 4.4 × 10^{-7} (show that value gives 3.7× 10^{-7}) Unit Ωm Example of calculation $\rho = RA / l$ = 22 Ω x 2.4 × 10^{-7} m^2 / 12 m = 4.4 × 10^{-7} Ωm	**(1)** **(1)** **(1)**	**3**
18(a)(iii)	A sensible response with some detail, e.g. • Avoid difficulty in reading a small scale while holding it and counting turns • it can be enlarged and done more accurately • compare with unravelling and using a micrometer • remains stationary, so easier to measure accurately • you can mark the coils as you go so you don't lose count (treat parallax as neutral and)	**(1)**	**1**
18(b)	Use of ratio of lengths × pd V = 8.2 V Example of calculation V = (7.0 cm / 10.2 cm) × 12 V = 8.2 V	**(1)** **(1)**	**2**
	Total for question 18		**9**

Question Number	Answer	Mark
***19(a)**	(QWC- Work must be clear and organised in a logical manner using technical wording where appropriate.) **Distance :** Speed of waves known **Or** refers to speed of light **(1)** Use (distance =) speed × time ÷ 2 **(1)** **Relative speed**: (Relative) speed indicated by a change in frequency **(1)** Larger change indicates a greater speed **(1)** **Amount of rain:** The intensity/amount of reflected signal increases as the amount of rain increases. **(1)** Reason for the larger signal **(1)** e.g. larger area, more drops or larger drops	**6**
19(b)(i)	Pulses, so the reflected signal is received before next one is sent **Or** otherwise there wouldn't be a way of telling which bit of reflected signal originated with which bit of emitted signal **Or** so that reflected pulses can be distinguished from each other **(1)** (Answers in terms of avoiding interference between two waves / standing waves not accepted)	**1**
19(b)(ii)	Use of $v = s/t$ with $v = 3 \times 10^8$ (m s^{-1}) **(1)** Selects the smaller distance 5 km **(1)** $t = 3.3 \times 10^{-5}$ s **(1)** <u>Example of calculation</u> $t = 5000 \text{ m} \times 2 / 3 \times 10^8$ m s^{-1} $t = 3.3 \times 10^{-5}$ s (Do not credit answers involving wavelength)	**3**
	Total for question 19	**10**

Question Number	Answer		Mark
20(a)	Calculates path difference = 12 (cm) Phase difference 0, 360° or 2π **Or** Calculates number of wavelengths in two paths Phase difference 0, 360° or 2π	(1) **(1)** **(1)** **(1)**	**2**
20(b)	Waves superpose **Or** interference between two waves takes place In phase constructive **Or** Antiphase destructive Links to <u>amplitude</u> maximum **Or** <u>amplitude</u> zero respectively In phase/constructive/max amplitude is where chocolate is hot with opposite at cold spots. **Or** Antiphase/destructive/min amplitude is where chocolate is cold with opposite at hot spots.	**(1)** **(1)** **(1)** **(1)**	**4**
20(c)	Coherent means a constant phase relationship (If the relationship not constant) a point could sometimes be constructive and sometimes destructive	**(1)** **(1)**	**2**
20(d)	Use of $c = f\lambda$ Calculates $c = 2.94 \times 10^8$ (m s^{-1}) **Or** λ = 12.2 (cm) **Or** f = 2500 (MHz) Sensible comment based on their calculated value. e.g. close to real value, so successful **Or** reference to uncertainty in data <u>Example of calculation</u> $c = 2.45 \times 10^9$ Hz × 0.12 m $c = 2.94 \times 10^8$ m s^{-1}	**(1)** **(1)** **(1)**	**3**
	Total for question 20		**11**

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